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PRELIMINARY DESIGN EXPERIMENTAL WATER TREATMENT PLANT

Conrad P. Straub

Public Health Service
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by

Conrad P. Straub, On Loan

U.S. Public Health Service

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PRELIMINARY DESIGN - EXPERIMENTAL WATER TREATMENT PLANT

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On October 29, 1948, a report (ORNL 48-10-377) prepared by O.R. Placak and R.J. Morton appeared entitled "Proposal For Evaluating The Impact of Water-Borne Radioactive Contaminants On Sanitary Engineering Facilities". This report called attention to the need for investigating the effect of radioactive substances upon the design and operation of sanitary facilities utilized by civilian or military populations, since limited background knowledge is available on this subject. They recommended that an experimental plant for the study of this problem should be provided. A later document was submitted requesting consideration for the appropriation of funds for the construction and operation of such an experimental plant during fiscal years 1949 and 1950.

The plans called for the construction of a building 75 feet long and 40 feet wide which would provide adequate space for housing the experimental water plants and special equipment, a laboratory, the necessary rest rooms, and other facilities. Drawings have been prepared for the building and have been submitted, through proper channels, for approval and authorization of construction.

This report will be concerned primarily with the design of the experimental water treatment plant facilities and of their approximate costs.

After completion of a tentative design, discussions relative to the proposed design were held with representatives of the Environmental Health Center, Public Health Service, Cincinnati, Ohio; Mr. John R. Baylis, Chicago's So. Side Filtration Plant; and various personnel associated with the equipment manufacturers. Several suggestions were made by the above group, based upon their experience with experimental and small plants, and these were incorporated in the intermediate design. It may be necessary to modify the design before final construction, as certain types of equipment may not be available in the form in which they are desired and laboratory studies now underway may suggest other modification. However, it is felt that these changes may not markedly affect the over-all design.

In the discussion which follows, each of the components of the plant will be treated individually.

General

Two parallel plants are planned, each designed for a uniform flow of 10,000 gallons per day or approximately 7 gallons

per minute. These plants will be completely inter-connected providing a maximum degree of flexibility to permit study of a wide variety of operating conditions. Basically, each plant shall consist of a reconstituting tank, a mixing tank, a combined coagulation-settling basin, two rapid sand filters, chlorinating facilities and a combined wash water tank and clear well.

Because of the difficulty of obtaining a suitable source of raw water economically, it was felt desirable to consider the use of a reconstituting tank. Through the use of such tanks, it will be possible to take tap water and to prepare it chemically to represent any raw water quality that it is desired to study. In addition, by this means, the raw water quality may be kept constant during the length of the particular run under investigation. Two types of coagulation equipment will be employed represented by the following manufacturers types, namely: the Dorr-type longitudinal flocculator and the Infilco-type Vorti-flocculator. With each plant two filters will be utilized. It is planned to utilize sand as a filtering medium in one of the units and Anthrafilt in the other, providing laboratory studies planned indicate the feasibility of such facilities.

Reconstituting Tank

As noted above, due to the difficulty of obtaining Clinch River raw water without recourse to a relatively expensive pipeline, the decision was made to use tap water in preparing water of the desired quality through the addition of the necessary chemical substances. One obvious drawback to such an arrangement is that the effect of the biological life usually encountered in raw water, is ignored. However, to overcome this disadvantage, comparative laboratory experiments may be conducted in parallel where the Clinch River raw water containing the incident biological life is compared with the reconstituted water. Differences between the two, provided the waters are alike with respect to their chemical and physical constituents, might be attributable to the influence of the biological life. Suitable corrections could then be applied to the results obtained from the use of reconstituted water in the experimental plants.

To provide for continuity of flow, it was felt that three tanks, each of 5000 gallons capacity, would be necessary. Two of the tanks would feed directly to the plant at any particular time, and the third would be utilized for preparing the raw water. All tanks would be inter-connected in such a manner that any one of them could be used to feed raw water to either of the two parallel plants.

The reconstituting tanks are so arranged that, for part of the time, flow to the respective water plants would be by gravity and during the remainder of the time it would be necessary to pump water from the tanks to the plant. It would be desirable, and an estimated cost for providing such facilities has been included, to equip the tanks with controls which would automatically start and stop the pumps at a pre-determined level and which would control the discharge. The necessary chemicals for preparing the raw water would be added and the contents mixed for several hours. Each tank would be equipped with a paddle for mixing. It is believed that two of the existing flocculation tanks may be utilized for this purpose, and one of the existing filters may be utilized for the third tank. This tank would have to be provided with a mixing paddle.

It has been reported that many types of automatic control devices are available at Y-12. This source should be investigated after the building plans have been authorized.

Mixing Tanks

To provide for intimate mixing of the coagulation or other treatment chemicals prior to further processing by either flocculation and/or settling, each plant is equipped with a mixing tank consisting of the following components: An outside tank 1.5

feet in diameter and 3 feet high with a water depth of 2 feet; and an inside unit of a 6" pipe supported 8 inches from the bottom. The necessary chemicals are fed into the central unit section and a "lightning" mixer provides the rapid mixing necessary for intimate mixing of the chemicals with the reconstituted raw water. This mixed water then flows downward and up the outside unit to the 2 inch outlet pipe. Four minutes detention time is allowed in the mixing tank.

These chemicals are fed to the mixing tank by means of ¾ Proportioneers ¾ type, (or equal) Triplex and Duplex chemical feeding equipment.

Coagulating - Settling Basins

After mixing, the treated water passes to the two coagulation basins. One of these provides for the use of two Infilco type (or equal) Vorti-floc units driven by means of a single motor, and the other, divided into two channels, provides for the use of two Dorr-type (or equal) longitudinal flocculators.

The coagulation tank, on which the Vorti-floc-type of flocculation equipment is to be utilized, is 4 feet wide, 7 feet long and 2.5 feet deep permitting a water depth of 1.5 feet and a 1 foot

freeboard. The second coagulation basin, which has the same overall dimensions, is divided into two longitudinal channels each 2 feet wide. Two Dorr-type flocculation units each 6-7 feet long are to be installed for flocculation. Each coagulation basin allows a detention time of 45 minutes.

Because of the small size of the treatment plant, and to minimize the danger of breaking the floc formed in the flocculation basin, it was decided to combine the coagulation and settling tanks into one unit. As a result the settling tank is a continuation of the coagulation tank but its dimensions are as follows: length 7 feet, width 4 feet, water depth 4 feet, overall depth 5 feet. One foot beyond the point of increased depth (as shown in the drawing) a wooden baffle is installed to assist in diverting the flow downward through the settling basin. This baffle is 4 feet long, 1 foot wide and 2 inches thick and should be of redwood or some other water resistant lumber and should be coated to reduce the possibility of absorbing radio-activity. The settling tanks are hopper-bottom and are provided with two hoppers, each having a depth of 1.75 feet. At the apex of each hopper a 2" sludge drain is to be installed.

An effluent launder is provided for removing the settled water, but its position is not definitely established and will be determined by observation after the plant has been placed in operation.

The effluent channel discharges into two pipes attached to each end of the channel which carry the effluent to the filters. Each settling tank serves two filters and the effluent from the settling tank discharges to each of the filters through three plug valves. The settling basin was designed to provide a detention time of 2 hours.

Filters

Two filters serve each of the settling tanks giving a total of 4 filters. Two of these, one for each plant, will use sand as the filtering medium and will be provided with the usual perforated pipe underdrainage system. The remaining two, will use Anthrafilt supported on the Camp porous plate bottom providing laboratory studies indicate that this is a suitable material from the radioactivity standpoint. The use of the two types of systems should provide comparative data on the value of these two types of filtering media and underdrainage systems in the treatment of waters containing radio-active substances.

Each filter unit consists of a box 2 feet wide, 2 feet long and 10 feet deep and will be provided with a central wash water gutter having an approximate cross-section of 0.25 square feet, and with the following appurtenances: wash water valve, re-wash valve (filter to waste), effluent valve, influent valve, wash water valve. A float valve will control the effluent opening to obtain uniformity of flow through the filter.

Two of the filters will be provided with 18" of gravel supporting 30" of filter sand, the other two will have 30" of Anthra-filt supported on the Camp-type porous filter bottom. With a filter box 10 feet deep, the former will allow a 5 foot water depth on top of the sand and a freeboard of 1 foot; the latter will allow a 5 foot water depth on top of the Anthrafilt and a freeboard of 2 feet.

Chlorinators

Two ¼ Proportioneers ¼-type (or equal) hypochlorinators will be utilized for chlorinating the filtered effluent.

Clear Water-Well-Wash Water Tank

Since the quantity of final processed water, which must be stored, is dependent upon the quantity of water required for backwashing the filters these tanks were combined into one unit in our case. The wash water tank has a capacity sufficiently large to permit the washing of two filters simultaneously with a 50 percent excess of water. This excess is included since no information is available as yet on the amount of radioactivity accumulated in the sand grains during filtration and whether larger quantities of water (prolonged washing) may have to be utilized in reducing the activity, if it occurs.

Pumping Equipment

Pumps having a capacity of approximately 10 gpm at a head of 25 feet are of sufficient size to pump water from the reconstituting tanks to the mixing tank.

Two pumps, each with a capacity of 80 gpm at a head of 20; will be used for back washing the filters. One unit is sufficient for our purposes; the other will serve as a spare and standby unit for other purposes.

Cost Estimate

A preliminary cost estimate was prepared indicating the cost of the equipment needed and the tanks for installing the two water treatment plants. The breakdown of the cost data is presented in the attached table. All tanks are to be of steel since these will be most easily decontaminated. For further ease of decontamination, strippable coatings should be used on the tanks if found practicable.

CPS:rr

ESTIMATED COST OF EXPERIMENTAL WATER TREATMENT PLANT EQUIPMENT

A. Breakdown as to Plant Units*

Reconstituting Tanks (exclusive of moving)	$850.00
Mixing Tanks	1650.00
Flocculation - settling units	2000.00
Filters	2000.00
Chlorination	500.00
	$7000.00
Contingencies 10%	700.00
Engineering 10%	700.00
Special equipment (Accelator, ion exchange, etc.)	2500.00
	$10900.00

B. Breakdown as to Types Equipment*

Mechanical Equipment	4000.00
Tanks	1725.00
Controls	500.00
Plumbing and valves	700.00
Miscellaneous	75.00
	$7000.00
Contingencies 10%	700.00
Engineering 10%	700.00
	$8400.00
Special Equipment (Accelator, ion exchange, etc.)	$2500.00
	$10900.00

* Note: Totals similar; different method of breakdown used.

SCHEMATIC DRAWING OF PROPOSED WATER TREATMENT PLANT

(Not to scale)